7.0 HUMAN INFRASTRUCTURE MODULE

7.1 Overview

The Human Infrastructure Module analyzes level of service (LOS) along U.S. 1 and hurricane evacuation times as a result of changes in land use for each scenario. Traffic and hurricane evacuation are highly interrelated and are of much interest to the local communities. For example, a building moratorium is in place for Big Pine Key due to an inadequate LOS on that segment of U.S. 1. The current ROGO takes into account the ability to evacuate the Florida Keys within 24 hours. This section discusses the traffic component of the module, its modifications resulting from the model test runs, and the integration of a pre-existing hurricane evacuation model into the CCIAM.

7.2 Traffic Component

7.2.1 Trip Generation Approach

The traffic component attempted to create a predictive model based on trip generation rates per land use categories and then estimating the LOS along U.S. 1 for each development scenario. For the test model, the predicted number of trips generated and attracted by each scenario was compared to existing measured traffic conditions that are found along U.S. 1 (FDOT Count Station Data) as a measure of change.

For a user-defined scenario, the CCIAM calculates the number of trips per day generated in each planning unit by land use category. There are no trip generation rates for land uses specific to Monroe County. Therefore trip generation rates are based on the *ITE Trip Generation Manual, 5th Edition* (ITE 1991). These rates are based on nationwide surveys and are the standard rates used in the industry, Monroe County, and FDOT. The CCIAM calculates trip generation by relating the land use acreage from the scenario-derived land use to a look-up table with coefficients for the number of trips generated per land use type. Trips by each land use type are summed to give the total number of trips generated in each planning unit.

The CCIAM then apportions the trips among segments depending on traffic patterns between origination and destination points. The number of trips allotted to a planning unit is calculated as the sum of internal-internal trips, internal-external trips, external-internal trips, and external-external trips. Internal-internal trips are those remaining within a planning unit; internal-external are those originating within a planning unit and ending in another planning unit, and external-internal trips are those originating in another planning unit and ending in the target planning unit.

The number of each type of trip is estimated by factoring the trip generation and trip attraction of each planning unit by the functional population, length of U.S. 1, and the average trip length for each planning unit. The average trip lengths are based on an origin/destination survey conducted at six locations along U.S. 1 in 1992.

The CCIAM further applies an empirical relationship between the volume-based capacities and the speed-based LOS methodology developed by the U.S. 1 LOS Task Force 1993. The U.S. 1 LOS Task Force is a multi-agency group with members from Monroe County, the FDOT, and the DCA. The methodology established by the task force is a procedure for using travel speeds as a means of assessing the LOS and reserve capacity of U.S. 1 in the unique setting of the Florida Keys (Table 7.1). Both Monroe County and the FDOT have adopted a LOS C standard for U.S. 1.

TABLE 7.1
LEVEL OF SERVICE CRITERIA FOR OVERALL SPEEDS ON U.S. 1 IN MONROE COUNTY

LOS	Criteria
LOS A	51 mph or above
LOS B	50.9 mph to 48 mph
LOS C	47.9 mph to 45 mph
LOS D	44.9 mph to 42 mph
LOS E	41.9 mph to 36 mph
LOS F	Below 36 mph

For the CCIAM, it was assumed that the segment travel speeds are proportional to the segment volume/capacity ratios (v/c). The existing v/c ratios for each segment of U.S. 1 were calculated using "Current Conditions" volumes (v) and roadway capacity (Table 7.2).

TABLE 7.2
ROADWAY CAPACITY PER TYPE OF ROAD

	2-Lane Undivided	4-Lane Undivided	4-Lane Divided
Uninterrupted Flow Conditions	14,000 vpd	32,100 vpd	33,800 vpd
Interrupted Flow Conditions	13,400 vpd	27,600 vpd	29,100 vpd

vpd = vehicles per day.

The following formula was used to estimate the delays associated with signals in uninterrupted flow segments to adjust the travel delays:

$$A= (1/ ((((1/TS)*3600*L)-25)/ (3600*L)))-TS),$$

Where, TS = travel speed and L = length of the segment.

The CCIAM compares the predicted travel speed for the scenario to the above LOS criteria to determine the resulting LOS.

7.2.2 Regression Approach

A test of this trip generation modeling method yielded widely diverging results and little correlation to documented traffic volume or LOS. The use of national trip generation rates may explain the discrepancy. However, other factors may have affected the predictive power of the model.

The study team investigated alternative methods of predicting LOS based on changes in land use. Given the level of uncertainty related to the trip generation rates by land use in the Florida Keys, a correlation analysis was attempted to determine if land use was correlated with traffic. The *2001 Monroe County Public Facilities Assessment* (Monroe County 2001) provides data regarding median traffic speed on U.S. 1 by segment throughout the Florida Keys. Using the parcel database, the acreage of different land uses was summarized (Table 7.3). A regression analysis revealed a statistically significant correlation ($p < 0.01$) between the density of tourist-related commercial and residential land uses per mile of U.S. 1 and the observed median speed along U.S. 1 (Figure 7.1).

The regression, while statistically significant, explains only about 30 percent of the variance in median speed among planning units. Undoubtedly, other factors affect median speed. Further examination of available information points to the effects of traffic lights and road capacity. For example, Key Deer Boulevard is a two-lane road with a traffic light and shows the lowest median speed. For any user-defined scenario, therefore, the resulting median speed can be estimated as a function of land use by applying the regression equation on Figure 7.1; the median speed is directly related to the LOS.

The regression equation (Figure 7.1) is used in the CCIAM to estimate the resulting median speed as a function of land use in the user-defined scenario.

FIGURE 7.1
RELATIONSHIP BETWEEN LAND USE AND MEDIAN SPEED ON U.S. 1

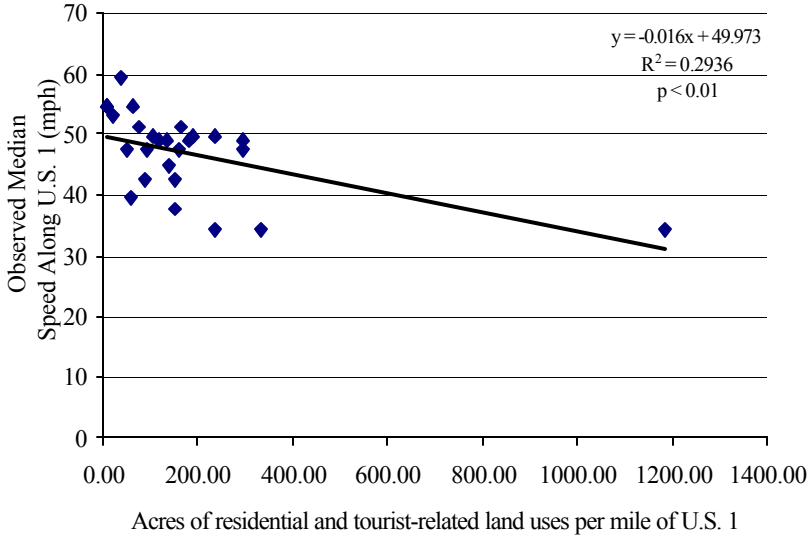

TABLE 7.3
MEDIAN SPEED ON U.S. 1 AND SELECTED LAND USES IN THE FLORIDA KEYS

Planning Unit	Observed Speed Along U.S. 1	Density of Residential and Tourist Related Land Uses (acre/mile)	Total Acreage Residential and Tourist Land Uses	Total Residential Acreage	Total Tourist Related Acreage*	Length of U.S. 1 (Miles)
Ocean Reef Club/ PAED 21 (North Key Largo)	48.9	179.58	1795.75	1400.88	394.87	10
PAED 19 and 20 (Garden Cove)	49.2	118.11	354.32	313.65	40.67	3
PAED 18 (John Pennecamp State Park)	49.7	235.92	589.80	540.52	49.27	2.5
PAED 17 (Rock Harbor)	49.7	188.50	565.49	514.43	51.06	3
PAED 16 (Rodriguez Key)	49.7	106.80	427.18	382.51	44.67	4
PAED 15 (Tavernier)	42.8	90.25	360.99	333.76	27.23	4
Plantation Key	42.5	153.35	843.41	814.92	28.49	5.5
Windley Key	39.5	59.73	119.45	32.88	86.57	2
Upper Matecumbe	51.3	166.29	914.58	415.61	498.96	5.5
Lower Matecumbe	54.5	62.38	343.09	306.47	36.62	5.5
Long Key/Layton	54.5	8.60	86.01	78.08	7.92	10
Key Colony Beach	51.3	74.72	672.46	466.23	206.23	9
Marathon Primary	37.7	152.44	1600.62	1225.27	375.35	10.5
Bahia Honda Key	54.7	9.78	68.45	68.45	0.00	7
Big Pine Key	34.5	234.68	821.38	774.01	47.38	3.5
Little Torch Key	47.6	94.50	189.00	175.50	13.49	2
BigTorch/ Middle Torch Key	47.6	297.13	148.56	148.44	0.12	0.5
Ramrod Key	47.5	51.49	128.71	123.20	5.51	2.5
Summerland Key	44.9	137.82	275.65	273.42	2.23	2
Cudjoe Key	47.6	159.31	318.61	314.77	3.85	2
Upper Sugarloaf	49.2	296.91	296.91	292.76	4.15	1
Lower Sugarloaf	49.2	133.19	399.58	375.74	23.85	3
Bay Point	53	19.80	49.49	48.35	1.14	2.5
Boca Chica	59.6	39.78	198.91	196.91	2.00	5
Stock Island	34.6	1183.71	1183.71	336.29	847.42	1
Key West	34.6	334.37	1337.49	863.13	474.36	4

* Tourist-related land uses include: commercial entertainment, golf course, marina, and hotel/motel, service.

7.3.2 Residential Capacity

Finally, the 2001 facilities assessment (Monroe County 2001) estimates that the reserve traffic volume for U.S. 1 is 44,513 trips. A formula developed by the U.S. 1 Task Force relates reserve volume with residential capacity, as follows (Monroe County 2001):

Reserve Capacity = Reserve Volume /(Trip Generation Rate * % Impact on U.S. 1)

Residential Capacity = 44,513/((8 trips/day/unit) * 0.8) = 6,955 units

Therefore, the number of additional housing units generated in a user-defined scenario is compared in the CCIAM with the residential capacity to determine if it surpasses the trip capacity of U.S. 1.

7.3 Hurricane Evacuation

The CCIAM relies on the recently completed *Florida Keys Hurricane Evacuation Study* (FKHES) produced for FDOT (Miller Consulting Inc. 2001), which estimates the time required to evacuate the Florida Keys up to Florida City in the event of a hurricane. The objectives of the FKHES were to create a documented public domain computer model to improve the traffic analysis subsystem and to automate the traffic assignment system. A special advisory team was assembled to discuss and agree upon all input variables required to run the model.

Twenty-eight model runs were performed, to include 1) Horizon Years 2000 and 2005, 2) early, normal, and late response curves to an evacuation notice, 3) Category 1-2 and 3-5 hurricanes, and 4) the three road improvement alternatives. Traffic incidents were also factored into the road alternatives including a drawbridge locked open, road flooding, and stalled or crashed vehicles. Output was displayed in tabular form for the study.

The model was used to evaluate the No Build Alternative and two other alternatives. The Transportation Systems Management (TSM) Alternative includes effective, low-cost traffic engineering improvements. The Permanent Improvement Alternative includes higher cost improvements to produce important capacity increase at key bottlenecks in the outbound direction. The improvements identified with these alternatives are based on the results of model runs used to identify improvement options that resulted in a reduction of the clearance time.

The FKHES model has 31 total links to reflect the roadway cross section and is divided into nine modules briefly described as follows:

- **Zonal Structure** – the spreadsheet-based model adopted the seven zones designated by the Monroe County Emergency Management Division including two zones for the Lower Keys, one zone for the Middle Keys, and four zones for the Upper Keys.

- **Socioeconomic Data** – the population and related information used in the model consist of three components: dwelling units, mobile home units, and tourist units. Population estimates begin with the official number of 1990 dwelling units recorded by the U.S. Census. Then Monroe County prepared data through 1999 according to certificates of occupancy issued each subsequent year. From 2000 to 2003, the county used the potential number of dwelling units available under permitting guidelines associated with the ROGO. The county projected the socioeconomic data to the year 2005 by using the rate of population change.

- **Storm Intensity** – the model emphasis was placed on the Category 3-5 hurricanes and assumed that all areas of the Florida Keys responded to evacuation advisories and/or orders.

- **Behavior Analysis** – Five elements associated with the behavior analysis included occupancy of tourist units, evacuation participation rates, destination desires/percentages, vehicle usage, and response curve. The Project Steering Committee (PSC) reviewed all of the input data for reasonableness and approved the input variables by zone.

- **Trip Generation** – this module computes the number of vehicles that leave from permanent dwelling units, mobile home units, and tourist units, which are further divided with four possible destinations: in-county public shelter, in-county friend/relatives, in-county hotel/motel, and out-of-county.

- **Trip Distribution/Shelters** – the trip table summarizes the number of vehicles traveling between zones (not leaving the Keys) and the number of vehicles exiting the Florida Keys from each zone assuming a hurricane Category 3-5 in the year 2005.

- **Trip Assignment** – the trip distribution was assigned onto the roadway network using the loading notes and percentages obtained form the previous hurricane evacuation studies.

- **Background Traffic** – this factor increases the level of traffic on the roadway system and has a direct effect on clearance time. It includes out-of-county traffic, non-evacuating vehicles conducting hurricane preparation trips, typical day commuting trips, etc.

- **Estimate of Clearance Time** – clearance time begins when the first evacuating vehicle enters the roadway network and ends when the last evacuating vehicle exits or passes the entrance to Florida's Turnpike on U.S. 1.

The FKHES involved extensive data collection relying primarily on readily available and previously collected data. In particular, the data from studies performed by PBS&J in 1991 and 1995 (Miller 2001) were used to prepare the input parameters for the hurricane evacuation model. The dwelling unit information used in the FKHES includes Mobile Home Dwelling Units, Other Residential Dwelling Units, and Tourist (seasonal) Residential Units.

The FKHES is a Microsoft Excel model that is executed in the CCIAM using Visual Basic for Applications. Nearly all of the CCIAM is automated with Visual Basic for Applications; therefore, linking to the FKHES is readily accomplished. Data regarding the number of dwelling units produced in each CCIAM scenario run will be summarized and input into the FKHES. The FKHES is not altered in any manner, other than to increase or decrease the number of dwelling units and other input parameters resulting from a land use scenario. Tabular outputs from the FKHES are available in conjunction with the outputs resulting directly from the CCIAM.

The study team is linking the pre-existing FKHES model to the CCIAM in order to take advantage of efforts sponsored by the state and Monroe County, similar to the Stormwater and Sanitary Wastewater Master Plans, Public Facilities Assessment, and the Key Deer Population Viability Analysis. Executing the FKHES model in coordination with the CCIAM is unique in that the CCIAM will pass data to the model that, in turn, generates information in support of assessing hurricane evacuation impacts resulting from user defined scenarios.